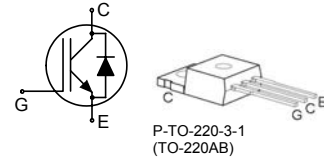


Low Loss DuoPack : IGBT in Trench and Fieldstop technology
with soft, fast recovery anti-parallel EmCon HE diode

- Short circuit withstand time – 10 μ s
- Designed for :
 - Soft Switching Applications
 - Induction Heating
- Trench and Fieldstop technology for 1200 V applications offers :
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - easy parallel switching capability due to positive temperature coefficient in $V_{CE(sat)}$
 - Very low $V_{ce(sat)}$
- Very soft, fast recovery anti-parallel EmCon™ HE diode
- Low EMI
- Application specific optimisation of inverse diode



Type	V_{CE}	I_C	$V_{CE(sat), T_J=25^\circ C}$	$T_{j,max}$	Marking	Package	Ordering Code
IHP10T120	1200V	10A	1.7V	150°C	H10T120	TO-220-3-1	Q67040-S4650

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current	I_C		A
$T_C = 25^\circ C$		16	
$T_C = 100^\circ C$		10	
Pulsed collector current, t_p limited by $T_{j,max}$	I_{Cpuls}	24	
Turn off safe operating area $V_{CE} \leq 1200V, T_J \leq 150^\circ C$	-	24	
Diode forward current	I_F		
$T_C = 25^\circ C$		11	
$T_C = 100^\circ C$		7	
Diode pulsed current, t_p limited by $T_{j,max}, T_C = 25^\circ C$	I_{Fpuls}	16.5	
Diode surge non repetitive current, t_p limited by $T_{j,max}$	I_{FSM}		A
$T_C = 25^\circ C, t_p = 10ms$, sine halfwave		28	
$T_C = 25^\circ C, t_p \leq 2.5\mu s$, sine halfwave		50	
$T_C = 100^\circ C, t_p \leq 2.5\mu s$, sine halfwave		40	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ¹⁾ $V_{GE} = 15V, V_{CC} \leq 1200V, T_J \leq 150^\circ C$	t_{SC}	10	μs
Power dissipation, $T_C = 25^\circ C$	P_{tot}	138	W
Operating junction temperature	T_J	-40...+150	$^\circ C$
Storage temperature	T_{stg}	-55...+150	
Soldering temperature, 1.6mm (0.063 in.) from case for 10s	-	260	

¹⁾ Allowed number of short circuits: <1000; time between short circuits: >1s.

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		0.9	K/W
Diode thermal resistance, junction – case	R_{thJCD}		2.6	
IGBT thermal resistance, junction – ambient	R_{thJA}		62	

Electrical Characteristic, at $T_j = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.5mA$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=10A$ $T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	1.7	2.2	
Diode forward voltage	V_F	$V_{GE}=0V, I_F=4A$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	1.65	2.15	mV
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.6mA, V_{CE}=V_{GE}$	5.0	5.8	6.5	
Zero gate voltage collector current	I_{CES}	$V_{CE}=1200V,$ $V_{GE}=0V$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	-	0.2	mA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	g_{fs}	$V_{CE}=20V, I_C=10A$	-	10	-	S
Integrated gate resistor	R_{Gint}		none			Ω

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V,$	-	606	-	pF
Output capacitance	C_{oss}	$V_{GE}=0V,$	-	48	-	
Reverse transfer capacitance	C_{riss}	$f=1MHz$	-	29	-	
Gate charge	Q_{Gate}	$V_{CC}=960V, I_C=10A$ $V_{GE}=15V$	-	53	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	-	13	nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC} \leq 10\mu s$ $V_{CC}=600V,$ $T_j=25^\circ C$	-	48	-	A

Switching Characteristic, Inductive Load, at $T_j=25^\circ C$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

IGBT Characteristic

Turn-on delay time	$t_{d(on)}$	$T_j=25^\circ C,$ $V_{CC}=610V, I_C=10A,$ $V_{GE}=0/15V,$ $R_G=81\Omega,$ $L_{\sigma}^{2)}=180nH,$ $C_{\sigma}^{2)}=39pF$ Energy losses include "tail" and diode reverse recovery.	-	45	-	ns
Rise time	t_r		-	20	-	
Turn-off delay time	$t_{d(off)}$		-	520	-	
Fall time	t_f		-	82	-	
Turn-on energy	E_{on}		-	0.68	-	mJ
Turn-off energy	E_{off}		-	0.78	-	
Total switching energy	E_{ts}		-	1.46	-	

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=25^\circ C,$	-	115	-	ns
Diode reverse recovery charge	Q_{rr}	$V_R=800V, I_F=4A,$	-	330	-	nC
Diode peak reverse recovery current	I_{rrm}	$di_F/dt=750A/\mu s$	-	7.15	-	A

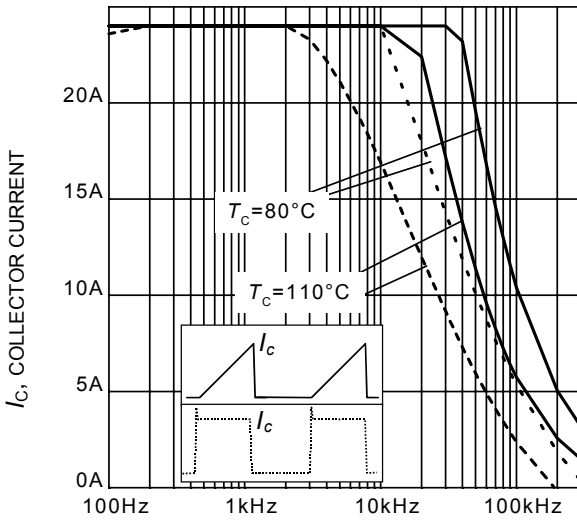
¹⁾ Allowed number of short circuits: <1000; time between short circuits: >1s.

²⁾ Leakage inductance L_{σ} and Stray capacity C_{σ} due to dynamic test circuit in Figure E.

Switching Characteristic, Inductive Load, at $T_j=150^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(\text{on})}$	$T_j=150^\circ\text{C}$, $V_{\text{CC}}=610\text{V}$, $I_{\text{C}}=10\text{A}$, $V_{\text{GE}}=0/15\text{V}$, $R_{\text{G}}=81\Omega$ $L_{\sigma}^{1)}=180\text{nH}$, $C_{\sigma}^{1)}=39\text{pF}$	-	45	-	ns
Rise time	t_{r}		-	24	-	
Turn-off delay time	$t_{d(\text{off})}$		-	592	-	
Fall time	t_{f}		-	177	-	
Turn-on energy	E_{on}	Energy losses include "tail" and diode reverse recovery.	-	0.83	-	mJ
Turn-off energy	E_{off}		-	1.19	-	
Total switching energy	E_{ts}		-	2.02	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=150^\circ\text{C}$	-	185	-	ns
Diode reverse recovery charge	Q_{rr}	$V_{\text{R}}=800\text{V}$, $I_{\text{F}}=4\text{A}$,	-	630	-	nC
Diode peak reverse recovery current	I_{rrm}	$di_{\text{F}}/dt=750\text{A}/\mu\text{s}$	-	8.1	-	A

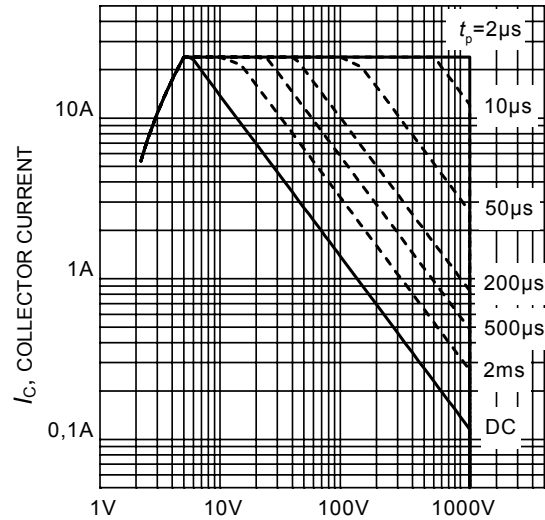
¹⁾ Leakage inductance L_{σ} and Stray capacity C_{σ} due to dynamic test circuit in Figure E.



f , SWITCHING FREQUENCY

Figure 1. Collector current as a function of switching frequency

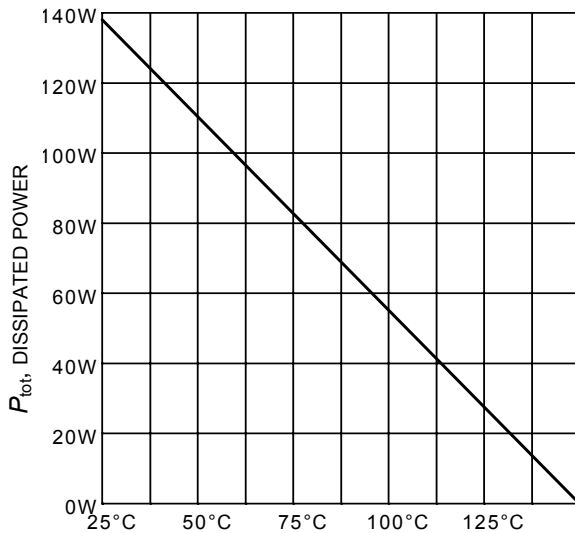
($T_j \leq 150^\circ\text{C}$, $D = 0.5$, $V_{CE} = 600\text{V}$,
 $V_{GE} = 0/+15\text{V}$, $R_G = 81\Omega$)



V_{CE} , COLLECTOR-EMITTER VOLTAGE

Figure 2. Safe operating area

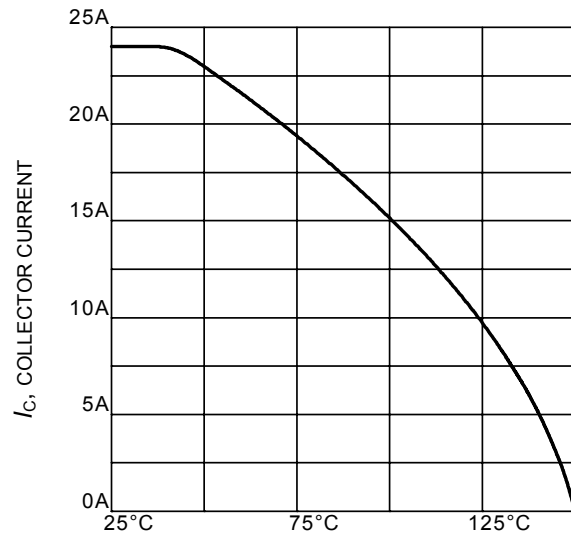
($D = 0$, $T_C = 25^\circ\text{C}$,
 $T_j \leq 150^\circ\text{C}$; $V_{GE} = 15\text{V}$)



T_C , CASE TEMPERATURE

Figure 3. Power dissipation as a function of case temperature

($T_j \leq 150^\circ\text{C}$)



T_C , CASE TEMPERATURE

Figure 4. Collector current as a function of case temperature

($V_{GE} \geq 15\text{V}$, $T_j \leq 150^\circ\text{C}$)

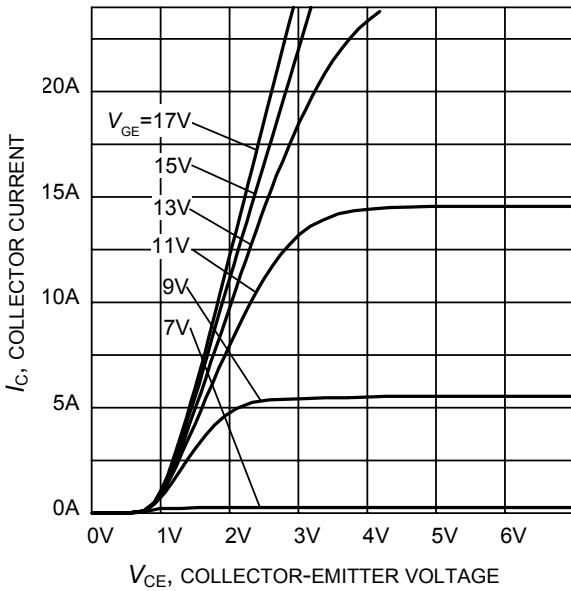


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

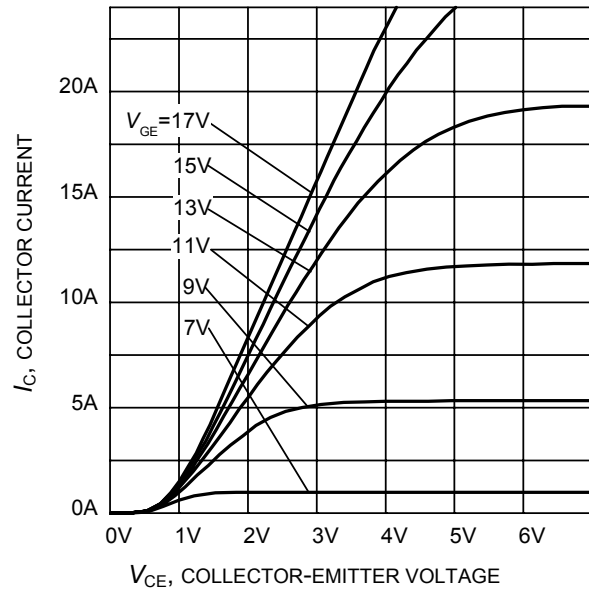


Figure 6. Typical output characteristic
($T_j = 150^\circ\text{C}$)

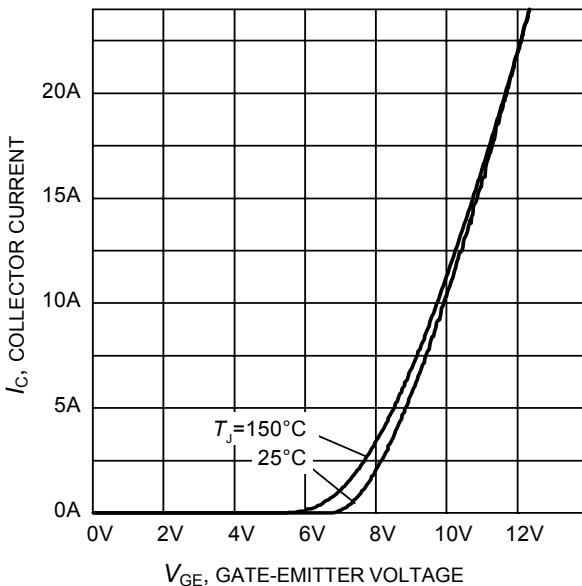


Figure 7. Typical transfer characteristic
($V_{CE} = 20\text{V}$)

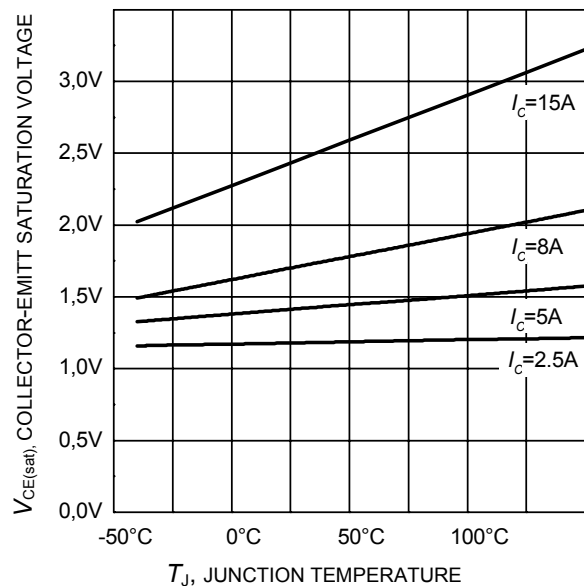


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

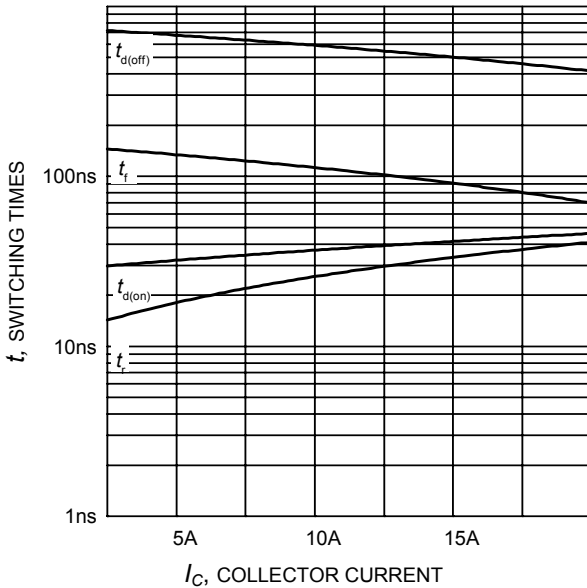


Figure 9. Typical switching times as a function of collector current
 (inductive load, $T_J=150^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=81\Omega$,
 Dynamic test circuit in Figure E)

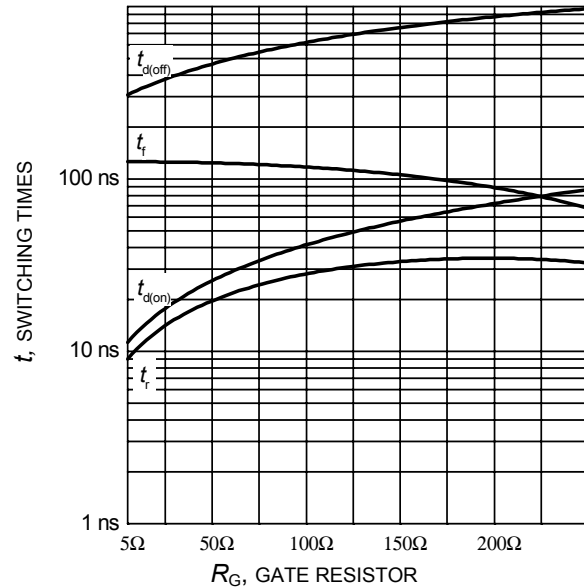


Figure 10. Typical switching times as a function of gate resistor
 (inductive load, $T_J=150^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=8\text{A}$,
 Dynamic test circuit in Figure E)

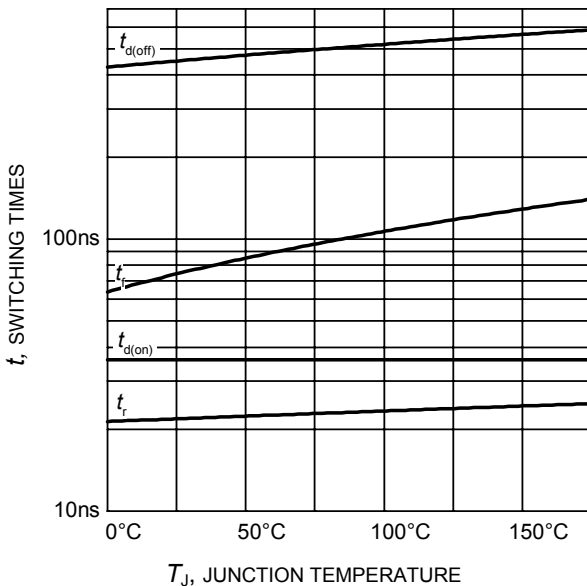


Figure 11. Typical switching times as a function of junction temperature
 (inductive load, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=8\text{A}$,
 $R_G=81\Omega$,
 Dynamic test circuit in Figure E)

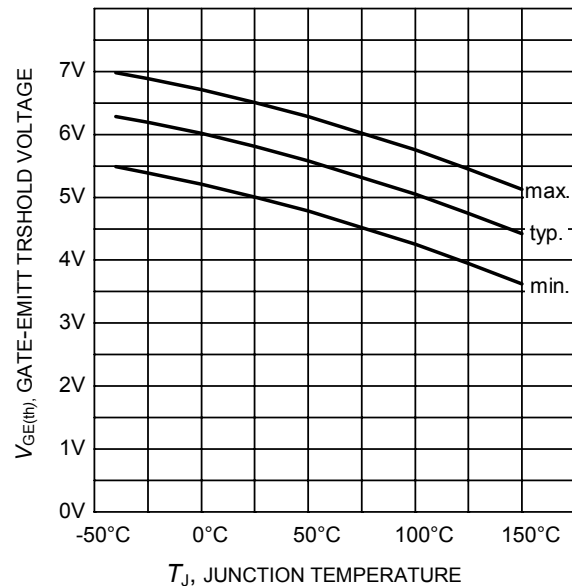


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
 ($I_C = 0.3\text{mA}$)

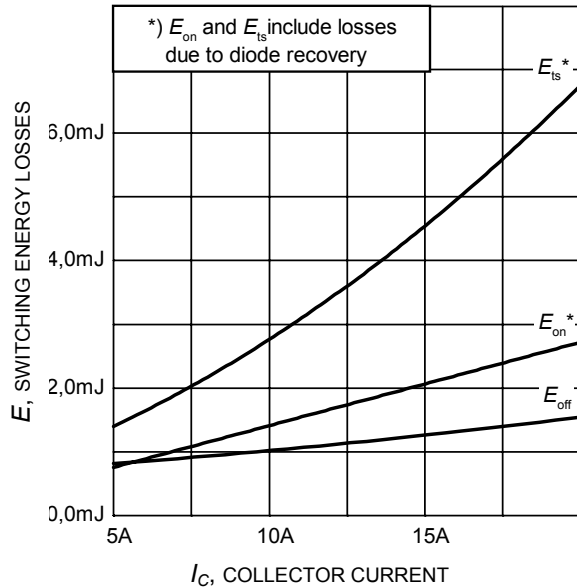


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=81\Omega$, Dynamic test circuit in Figure E)

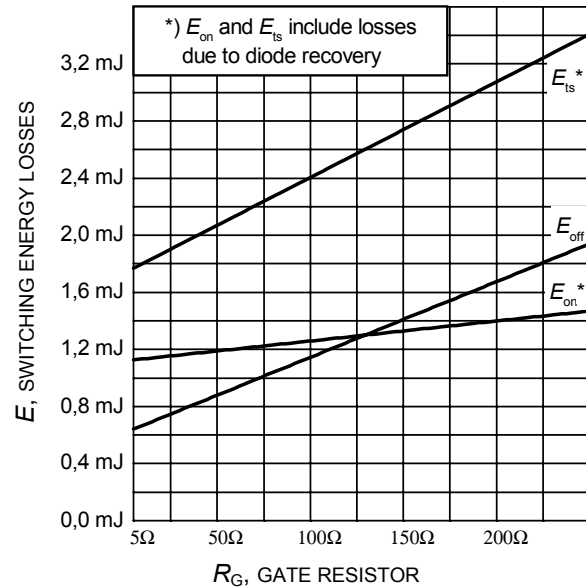


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=8\text{A}$, Dynamic test circuit in Figure E)

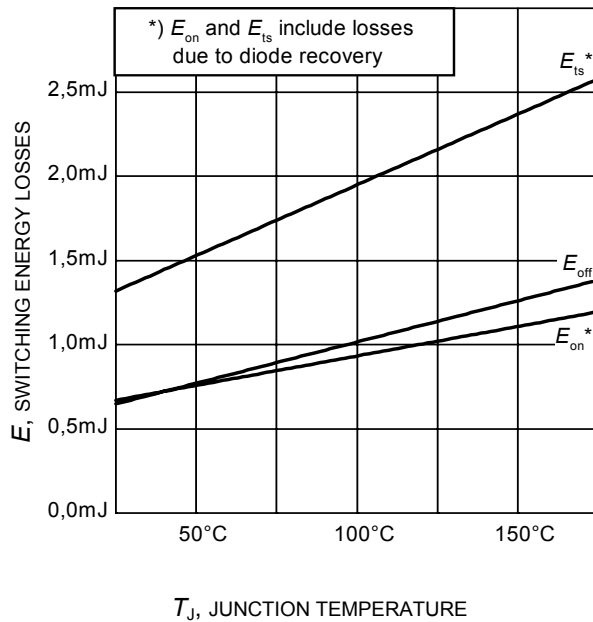


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=8\text{A}$, $R_G=81\Omega$, Dynamic test circuit in Figure E)

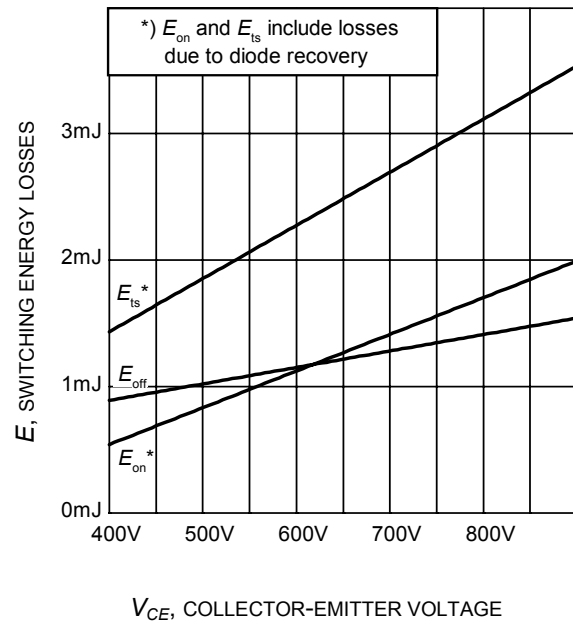


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J=150^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=8\text{A}$, $R_G=81\Omega$, Dynamic test circuit in Figure E)

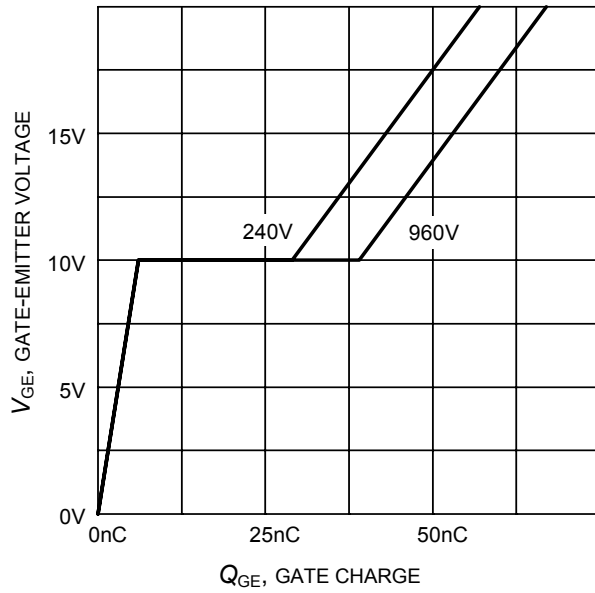


Figure 17. Typical gate charge
($I_C=8\text{ A}$)

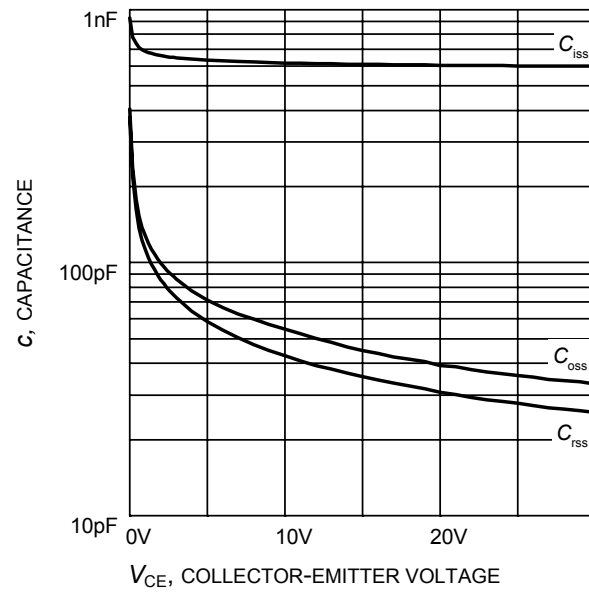


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

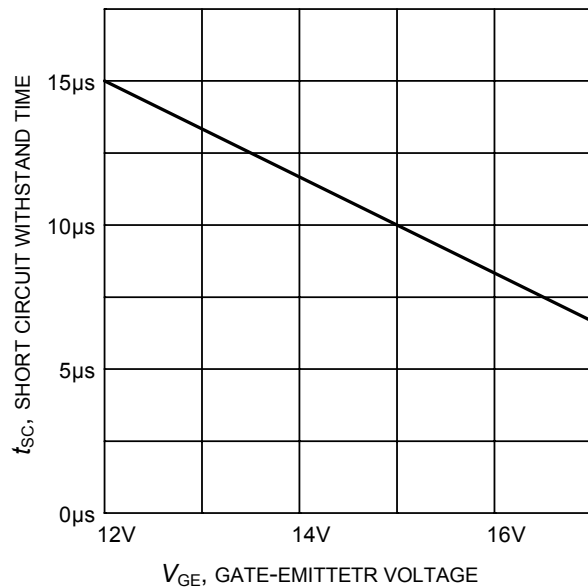


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=600\text{V}$, start at $T_J=25^\circ\text{C}$)

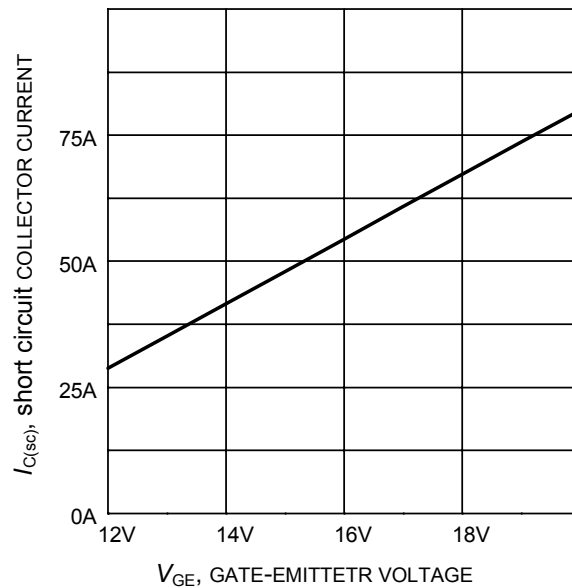


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 600\text{V}$, $T_J \leq 150^\circ\text{C}$)

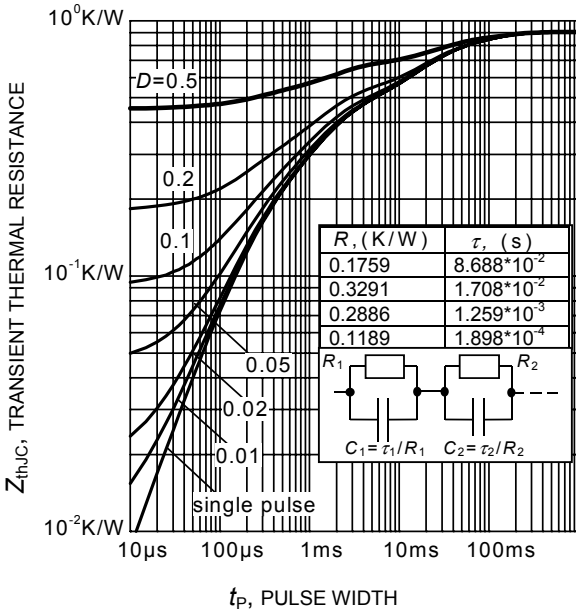


Figure 23. IGBT transient thermal resistance as a function of pulse width
($D = t_p / T$)

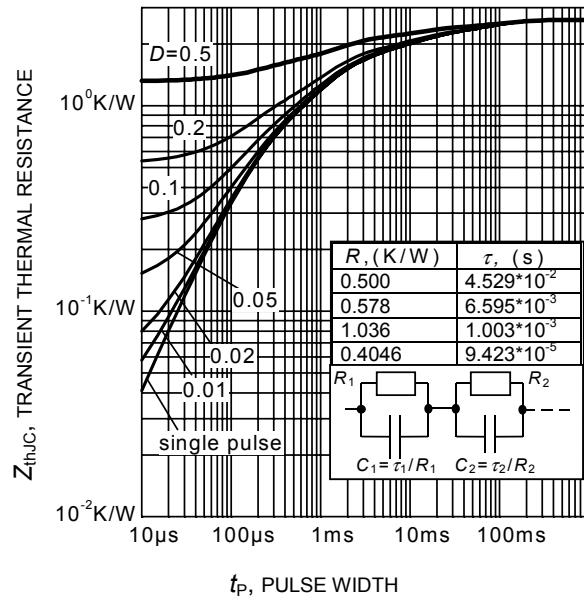


Figure 24. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

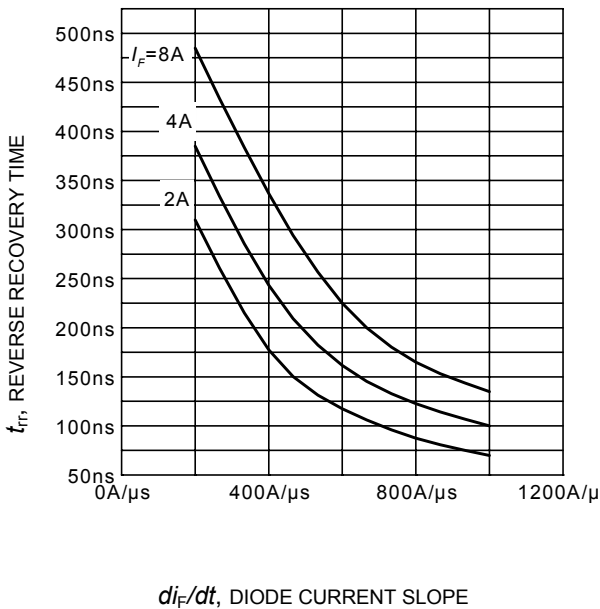


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 600V$, $I_F = 8A$,
Dynamic test circuit in Figure E)

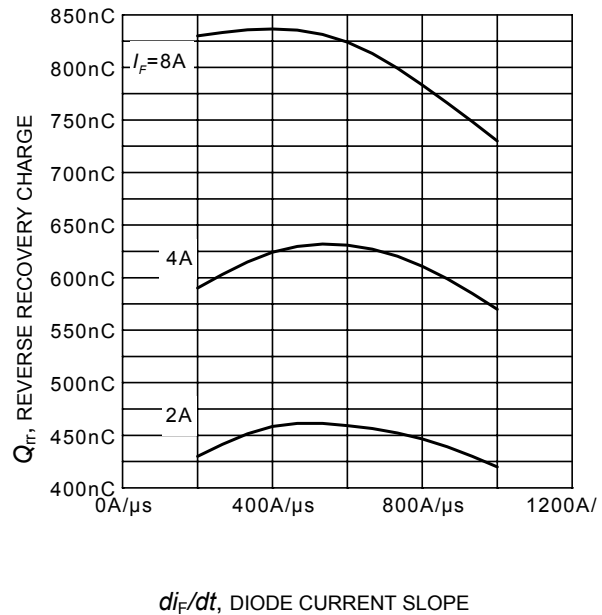
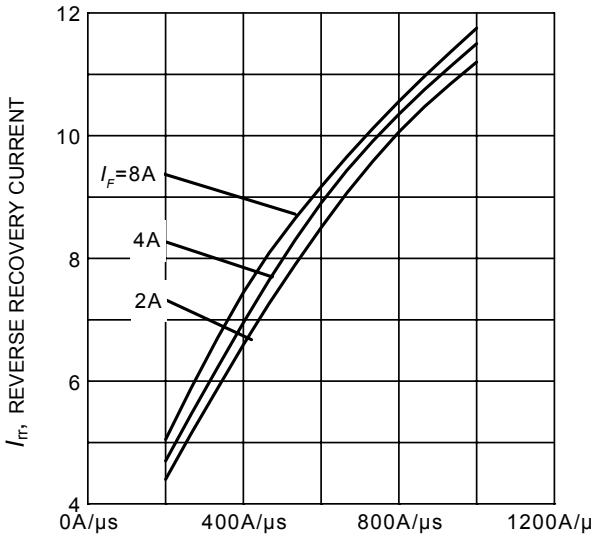
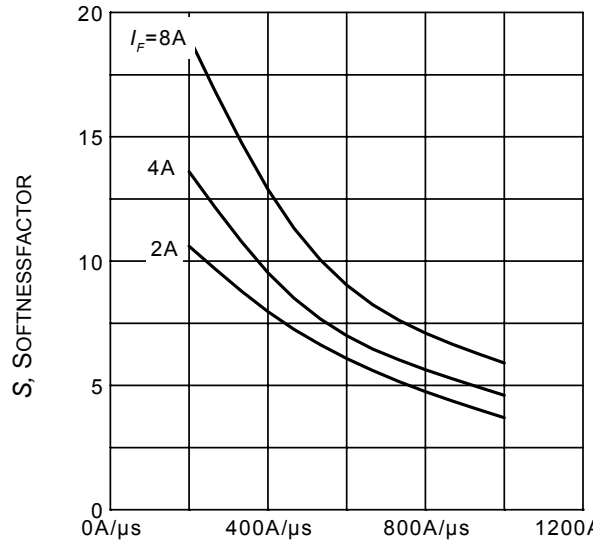


Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 800V$, $T_J = 125^\circ C$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

Figure 25. Typical reverse recovery current as a function of diode current slope
 ($V_R=800V$, $T_J = 125^\circ C$,
 Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

Figure 26. Typical reverse recovery softness factor as a function of diode current slope
 ($V_R=800V$, $T_J = 125^\circ C$,
 Dynamic test circuit in Figure E)

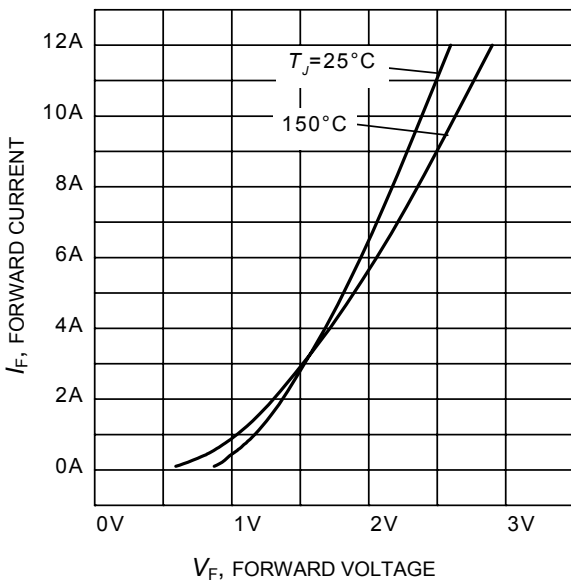


Figure 27. Typical diode forward current as a function of forward voltage

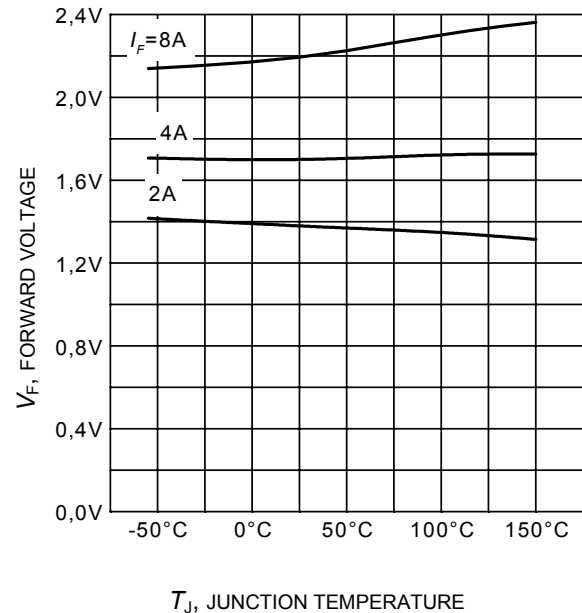
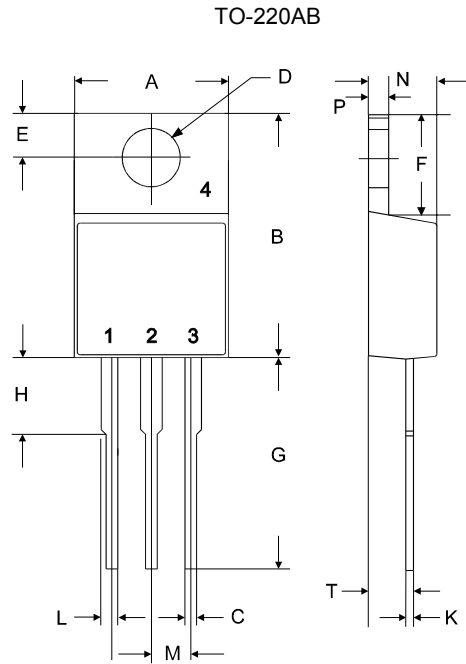


Figure 28. Typical diode forward voltage as a function of junction temperature



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.70	10.30	0.3819	0.4055
B	14.88	15.95	0.5858	0.6280
C	0.65	0.86	0.0256	0.0339
D	3.55	3.89	0.1398	0.1531
E	2.60	3.00	0.1024	0.1181
F	6.00	6.80	0.2362	0.2677
G	13.00	14.00	0.5118	0.5512
H	4.35	4.75	0.1713	0.1870
K	0.38	0.65	0.0150	0.0256
L	0.95	1.32	0.0374	0.0520
M	2.54 typ.		0.1 typ.	
N	4.30	4.50	0.1693	0.1772
P	1.17	1.40	0.0461	0.0551
T	2.30	2.72	0.0906	0.1071

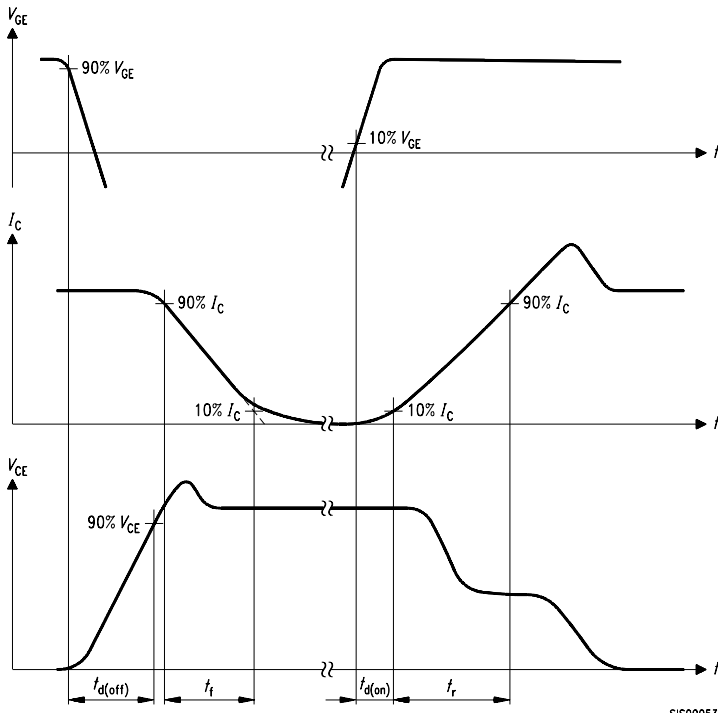


Figure A. Definition of switching times

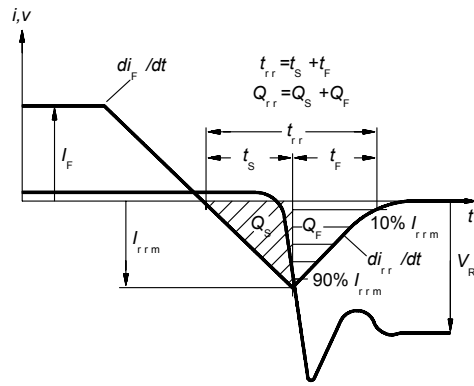


Figure C. Definition of diodes switching characteristics

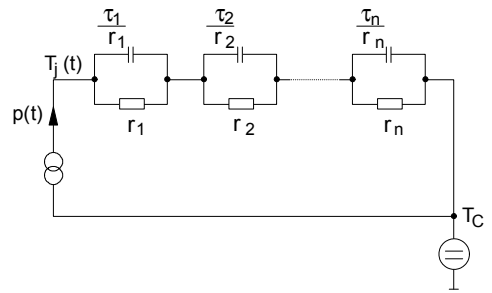


Figure D. Thermal equivalent circuit

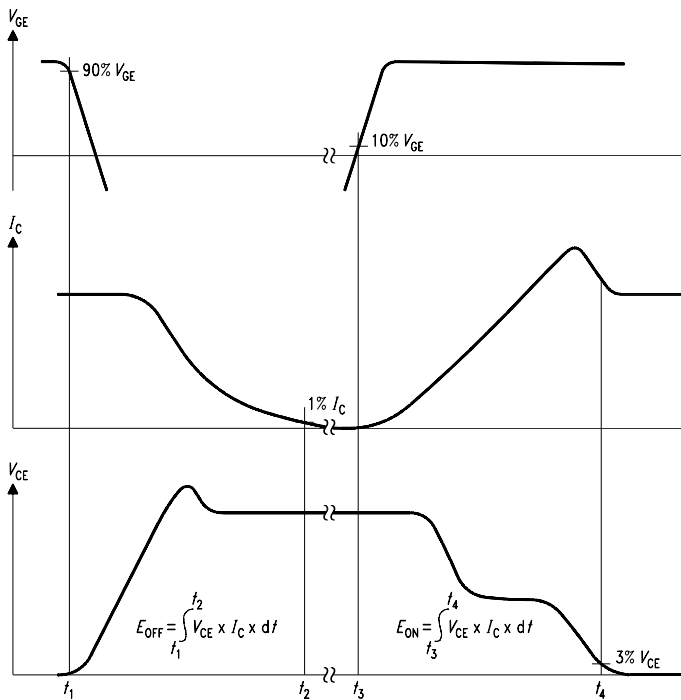


Figure B. Definition of switching losses

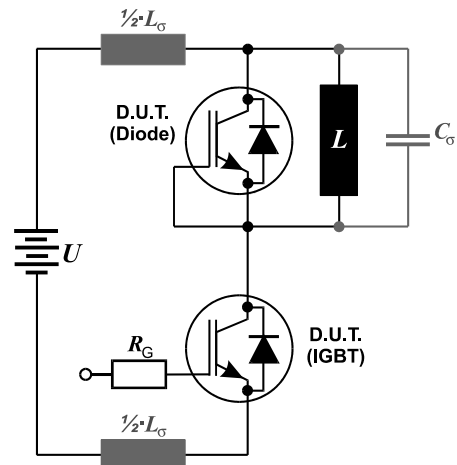


Figure E. Dynamic test circuit
Leakage inductance $L_\sigma = 180\text{nH}$
and Stray capacity $C_\sigma = 39\text{pF}$.

Published by
Infineon Technologies AG,
Bereich Kommunikation
St.-Martin-Strasse 53,
D-81541 München
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